Worksheet Combined Gas Law And Ideal Gas Law

South Pasadena • Chemistry

Name ______________________
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12 • The Gas Laws

THE COMBINED GAS LAW

In practical terms, it is often difficult to hold any of the variables constant. When there is a change in pressure, volume and temperature, the combined gas law is used.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \quad \text{or} \quad P_1 \times V_1 \times T_2 = P_2 \times V_2 \times T_1$$

$$K = °C + 273$$

See scratch paper

Complete the following chart.

	P_1	V_1	T_1	P_2	V_2	T_2
1	1.50 atm	3.00 L	293 K ~~20.0 °C~~	2.50 atm		303 K ~~30.0 °C~~
2	720. torr	256. mL	298 K ~~25.0 °C~~		250. mL	323 K ~~50.0 °C~~
3	600. mmHg	2.50 L	325 K ~~22.0 °C~~	760. mmHg	1.80 L	
4		750. mL	273 K ~~0.00 °C~~	2.00 atm	500. mL	298 K ~~25.0 °C~~
5	95.0 kPa	4.00 L		101. kPa	6.00 L	471. K or ~~198. °C~~
6	650. torr		373 K ~~100. °C~~	900. torr	225. mL	423 K ~~150. °C~~
7	850. mmHg	1.50 L	288 K ~~15.0 °C~~		2.50 L	303 K ~~30.0 °C~~
8	125. kPa	125. mL		100. kPa	100 mL	348 K ~~75.0 °C~~

Worksheet combined gas law and ideal gas law are essential tools in the study of chemistry and physics, providing a framework for understanding the behavior of gases under various conditions. These laws allow scientists and students alike to predict how gas variables will change in response to alterations in pressure, volume, and temperature. This article will delve into the principles behind the combined gas law and the ideal gas law, explaining their applications, key formulas, and how to effectively use a worksheet to solve problems related to these concepts.

Understanding the Ideal Gas Law

The ideal gas law is a fundamental equation that relates the pressure, volume, temperature, and amount of a gas. The formula for the ideal gas law is expressed as:

$$PV = nRT$$

Where:
- P = pressure of the gas (in atmospheres or pascals)
- V = volume of the gas (in liters or cubic meters)
- n = number of moles of the gas
- R = ideal gas constant (0.0821 L·atm/(K·mol) or 8.314 J/(K·mol))
- T = temperature of the gas (in Kelvin)

The Assumptions of Ideal Gases

The ideal gas law is based on several key assumptions about gas behavior:

1. Gas Particles are Small: The volume of individual gas particles is negligible compared to the volume of the container.
2. No Intermolecular Forces: There are no forces of attraction or repulsion between gas molecules.
3. Elastic Collisions: Collisions between gas particles and the walls of the container are perfectly elastic, meaning no energy is lost.
4. Random Motion: Gas particles are in constant, random motion.

These assumptions make the ideal gas law applicable under many conditions, although real gases may deviate from this behavior under high pressure or low temperature.

The Combined Gas Law

The combined gas law is a powerful equation that combines Boyle's Law, Charles's Law, and Gay-Lussac's Law. This law is useful for solving problems involving a gas when multiple variables change simultaneously. The formula is expressed as:

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Where:
- P_1, V_1, and T_1 are the initial pressure, volume, and temperature.
- P_2, V_2, and T_2 are the final pressure, volume, and temperature.

Individual Gas Laws Explained

To better understand the combined gas law, it's beneficial to explore the individual gas laws it encompasses:

- Boyle’s Law: States that the pressure and volume of a gas are inversely proportional at constant temperature.
$$P_1V_1 = P_2V_2$$

- Charles's Law: States that the volume of a gas is directly proportional to its temperature at constant pressure.
$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

- Gay-Lussac's Law: States that the pressure of a gas is directly proportional to its temperature at constant volume.
$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

Applications of the Ideal Gas Law and Combined Gas Law

The ideal gas law and combined gas law have numerous practical applications in various fields, including:

1. Chemistry: Calculating the behavior of gases in reactions.
2. Engineering: Designing systems that involve gas compression and expansion.
3. Meteorology: Understanding atmospheric pressure and weather patterns.
4. Environmental Science: Analyzing gas emissions and their effects on climate change.

Using Worksheets for Problem-Solving

Worksheets are an effective way to practice and master the concepts of the ideal gas law and combined gas law. Here's how to create and utilize a worksheet for effective learning:

- Step 1: Understanding the Problem: Read the problem carefully to identify the known and unknown variables. Determine which law applies (ideal gas law or combined gas law).

- Step 2: List Known Variables: Write down all known values from the problem, including units.

- Step 3: Identify Relationships: Decide on the relationships between the variables using the appropriate formulas.

- Step 4: Solve for the Unknown: Rearrange the formula to solve for the unknown variable. Make sure to keep track of units and convert them as necessary.

- Step 5: Check Your Work: After calculating, revisit the problem to ensure that the answer makes sense physically and is in the correct units.

Sample Worksheet Problems

Here are a few sample problems that can be included in a worksheet to practice using the ideal gas law and combined gas law:

Problem 1: Ideal Gas Law

A gas occupies a volume of 2.0 L at a pressure of 1.0 atm and a temperature of 300 K. How many moles of the gas are present?

Solution:
Using the ideal gas law:
\[PV = nRT \]
\[n = \frac{PV}{RT} \]
Substituting the values:
\[n = \frac{(1.0 \, atm)(2.0 \, L)}{(0.0821 \, L \cdot atm/(K \cdot mol))(300 \, K)} \]
Calculate \(n \) to find the number of moles.

Problem 2: Combined Gas Law

A gas has a pressure of 2.0 atm and a volume of 5.0 L at a temperature of 250 K. If the pressure is changed to 1.0 atm and the temperature is increased to 300 K, what will be the new volume of the gas?

Solution:
Using the combined gas law:
\[\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \]
Rearranging for \(V_2 \):
\[V_2 = \frac{P_1V_1T_2}{P_2T_1} \]
Substituting the known values:
\[V_2 = \frac{(2.0 \, atm)(5.0 \, L)(300 \, K)}{(1.0 \, atm)(250 \, K)} \]
Calculate \(V_2 \) to find the new volume.

Conclusion

Understanding the worksheet combined gas law and ideal gas law is crucial for anyone studying the behavior of gases. Mastery of these laws enables students and professionals to make accurate predictions about gas behavior in various scenarios. By using structured worksheets, learners can practice problem-solving skills, reinforcing their understanding of gas laws and their applications. With the ideal gas law providing a broad overview of gas behavior and the combined gas law allowing for more specific calculations, these tools are invaluable in scientific studies and practical applications alike. Whether in a classroom or a laboratory, the principles of gas laws remain fundamental to the field of physical science.

Frequently Asked Questions

What is the Combined Gas Law and how does it relate to the Ideal Gas Law?

The Combined Gas Law combines Boyle's Law, Charles's Law, and Gay-Lussac's Law, relating pressure, volume, and temperature of a gas. The Ideal Gas Law, PV=nRT, simplifies the relationship by incorporating the number of moles, allowing calculations for ideal gases under varying conditions.

How can the Combined Gas Law be used to solve real-world problems involving gas mixtures?

The Combined Gas Law can be applied to determine changes in pressure, volume, or temperature of a gas mixture when conditions change, such as in a balloon expanding in the heat, by rearranging the formula to isolate the desired variable.

What are some assumptions made when applying the Ideal Gas Law?

The Ideal Gas Law assumes that gas particles do not attract or repel each other, occupy no volume, and undergo elastic collisions. These assumptions are generally valid at high temperatures and low pressures but fail for real gases under extreme conditions.

How can you derive the Ideal Gas Law from the Combined Gas Law?

To derive the Ideal Gas Law from the Combined Gas Law, we express the Combined Gas Law as P1V1/T1 = P2V2/T2. By keeping the number of moles constant and rearranging the equation, we can isolate the product PV, leading to the form PV=nRT, where R is the ideal gas constant.

In what scenarios should the Combined Gas Law be preferred over the Ideal Gas Law?

The Combined Gas Law should be preferred when dealing with problems involving changes in pressure, volume, or temperature for a fixed amount of gas, especially in situations where the gas behaves non-ideally, or when the number of moles is not constant.

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